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Circular No. 918

June 1953 • Washington, D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE

Forage Utilization by Cattle on Northern Great Plains Ranges

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CONTENTS

Page
The problem and how it was studied 1
Development and utilization of important forage species 5
  Distribution of forage species 5
  Season of growth 6
  Season of use 7
  Degree of utilization 9
Utilization varied from year to year 9
  Fluctuations on summer range 10
  Fluctuations on winter range 11
Utilization varied by range subtypes 12
Utilization varied by stocking rates 15
Utilization varied with distance from stock water 19
Utilization and management on a range basis 21
  Proper stocking is the key 21
  Use each species when it is most important as forage 23
A practical method of determining forage utilization 24
Summary 25
Common and scientific names of plants mentioned 27

THE PROBLEM AND HOW IT WAS STUDIED

One of the most important problems of rangeland management in the northern Great Plains region is how to obtain the proper degree of grazing on the range. This region, comprising the western half of North and South Dakota, the northeastern quarter of Wyoming, and the eastern two-thirds of Montana, is one of the most important range cattle areas in the West. In 1951 approximately 3 million cattle and calves were in this area. Yearlong grazing on these plains ranges is a common practice, but extreme winter conditions sometimes make supplemental feeding necessary. Average annual precipitation varies from 10 to 16 inches over the region, with great fluctuations from year to year. This vast area extending from the foothills of the Rocky Mountains to about the 100th meridian is often called short-grass or mixed-prairie range.

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[1] In cooperation with the Bureau of Animal Industry, United States Department of Agriculture, and Montana Agricultural Experiment Station. The authors gratefully acknowledge the assistance of many members of all the cooperating agencies but especially that of Leon C. Hurtt, formerly in charge of the Division of Range Research, Northern Rocky Mountain Station. Mr. Holscher is now with the Pacific Northwest Forest and Range Experiment Station.

Utilization on a given area is determined by forage production, length of grazing season, and number of livestock grazed per unit of range. While length of season and numbers of livestock can be closely controlled and adjusted as forage production fluctuates, forage production itself, which is affected by weather, can only be indirectly influenced through management. In wet years, considerable herbage may be left on the ground, whereas in dry years the range may be too closely grazed unless adjustments are made in livestock numbers or length of the season. The basis of a sound, highly productive range livestock operation therefore is a proper balance between supplies of forage and feed and livestock numbers.

The problem of forage utilization and proper stocking was studied from 1939 through 1945 at the United States Range Livestock Experiment Station, Miles City, Mont. A representative area of northern Great Plains rangeland, lying in the confluence of the Yellowstone and Tongue Rivers, was used. Two sets of six experimental range pastures were established in the early thirties, one set on rather gently rolling land used as summer range and the other set, located in rougher country, for winter grazing. In the fall of 1937 they were stocked with bred 2-year-old heifers.[2] These animals were in the range pastures until the end of 1945. The summer grazing season ordinarily extended from May 15 until November 15 each year and the winter season included the remaining 6 months. Two pastures of each set were lightly stocked, 3.2 acres per cow-month; two, moderately stocked, 2.5 acres per cow-month; and two were heavily stocked, 1.9 acres per cow-month.

All of the range pastures were similar. Except for one subtype in one area, three typical northern Great Plains range subtypes were represented in each. The pastures were wedge-shaped, and each set radiated from a central well (fig. 1), from which stock water was equally accessible. Salt was judiciously placed in each range pasture as an aid in obtaining uniform distribution of grazing. Temporary surface water located on the far side of most of the pastures aided distribution but did not materially affect results of the study. Topography was not a factor in distribution of grazing on either the summer or winter range pastures.

Records were kept of the dominant species that contributed the bulk of the forage for the cattle. On the summer range, observations were first made in 1939 and repeated yearly through 1945, while on the winter range, the observations were made only in 1939–41, and 1945. The two species most closely observed and studied were bluestem wheatgrass and blue grama. Supplemental data were collected on needle-and-thread, threadleaf sedge, buffalograss, silver sagebrush, and black greasewood. Threadleaf sedge, silver sagebrush, and black

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[2] A similar group of experimental animals was run in the range pastures from July 1932 until August 1936.

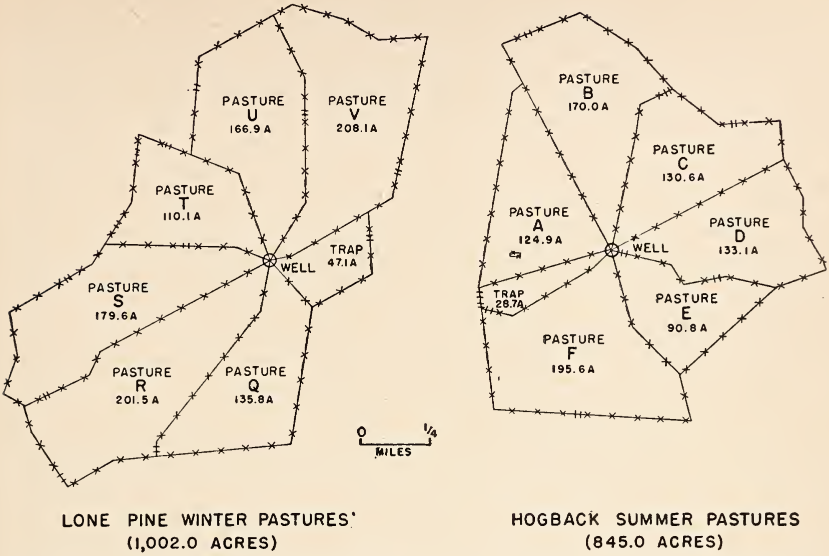

Figure 1.—Experimental range pastures at the United States Range Livestock Experiment Station, Miles City, Mont.

greasewood were not found in sufficient abundance to permit reliable estimates of utilization on the summer range and, for the same reason, no measurements were made of buffalograss on the winter range.

Lines were run across the pastures at varying distances from the central wells. The first lines were located 5 chains (330 feet) from the well and thereafter the transects were spaced at 10-chain intervals. Records were made along these lines of the height of grazed stubbles and of whether each species nearest a designated mark was grazed.[3] Observations of buffalograss, silver sagebrush, and black greasewood consisted merely of recording whether or not the nearest plant of each species was grazed.

Forage utilization was calculated as the weight of that part of the forage plants, by species, removed at the various stubble heights, multiplied by the percent of plants grazed. The weight of herbage removed by grazing equaled the difference between the weight of the ungrazed plants and that of the part left after grazing. An earlier study used distribution of weight in relation to grazed plant height in determining utilization,[4] and in the study reported here a similar procedure was followed for each major species. To illustrate the method, suppose the average stubble height of bluestem wheatgrass is

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[3] Plants of blue grama, needle-and-thread, and threadleaf sedge were not recorded as being grazed unless the herbage above 50 percent or more of the basal area had been removed. Tests showed that this system gave the same utilization percentage as did estimates in units of 10 percent.

[4] Collins, Robert W., and Hurtt, Leon C. a method for measuring utilization of bluestem wheatgrass on experimental range pastures. Ecology 24: 122–125, illus. 1943.

3 inches. A weight-distribution curve for this species shows that 64 percent of the weight is removed when the plants are grazed at this stubble height (fig. 2). If 55 percent of the bluestem wheatgrass plants were grazed at that level, the estimated utilization for this species would be 35 percent.

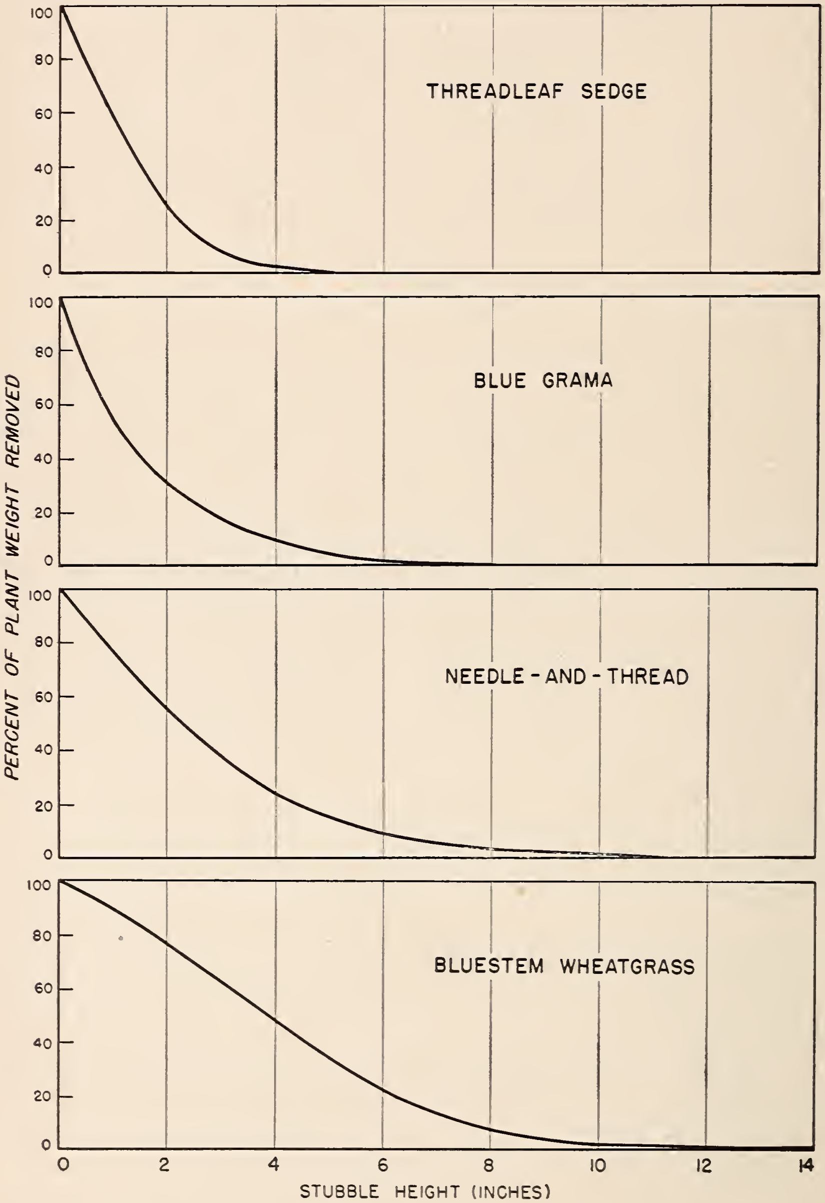

FIGURE 2.—Percent of plant weight removed at different stubble heights for four important northern Great Plains range species.

Although a large part of the weight of most of the species observed lies close to the ground and much of the herbage cannot be grazed by livestock, the entire plant was considered in measuring utilization. Because growing conditions vary from year to year, the growth form of plants varies also; it was therefore necessary to determine weight distribution each year.

This 7-year study revealed variations in utilization from year to year, between different range subtypes and at varying distances from stock water. Results of the study provide a basis for the determination of proper utilization and suggest a few ways of obtaining that degree of grazing on the range.

DEVELOPMENT AND UTILIZATION OF IMPORTANT FORAGE SPECIES

Although the bulk of the forage in the northern Great Plains is provided by only a few species, mainly grasses, no single species can be designated as the most important because each is a part of the vegetation that composes the range and helps to provide forage. Growth habits and forage values are unequal but each species is grazed to some extent at some time during the year. Each is affected by weather, by grazing, and by a number of other factors that may cause great variation in its development and utilization. Some species are very palatable and eagerly sought by cattle, but because they are sparsely distributed or do not provide much herbage, cannot be classed as highly important. Other species are not especially attractive to grazing animals under ordinary circumstances.

Distribution of Forage Species

Generally, the distribution of forage plants is closely related to soil type, aspect, and topography. In this region bluestem wheatgrass is characteristic of heavy soils but has a wide range of adaptability. Although every range subtype has bluestem as one of its major components, there are variations in the amounts present. Generally, bluestem occurs less frequently in the rolling upland parts of the range than in other subtypes having heavier soils. In the summer pastures, this species was recorded at about nine-tenths of all the utilization survey stations. Considerably fewer plants were found in the winter pastures where the topography was rougher and the range subtypes more diverse. While buffalograss was closely associated with bluestem on the heavy soils, it occurred much less frequently than bluestem in the experimental range pastures.

Blue grama, another very important forage species, is generally distributed throughout the lighter, better-drained soil types. It seldom occurs on heavy soils and is almost never found where drainage is poor or soils highly alkaline. Based on records of its occurrence made during the utilization surveys, blue grama was slightly less prevalent on summer than on winter range. Somewhat more than half of the survey stations on summer range had some blue grama.

Closely associated with blue grama but perhaps even more restricted to sandy, well-drained soils are threadleaf sedge and needle-and-thread grass. These species, important for early spring and summer-fall forage, respectively, were both prevalent on the experimental winter range. On the summer range, threadleaf sedge was too sparse to warrant observation. Needle-and-thread was perhaps more prevalent on this area than on the winter range.

Sandberg bluegrass, an important early growing species, is well distributed over the range with little regard to soil type, topography, or vegetation type. It is chiefly valuable as a forage species in the very early spring, but occasionally it provides additional forage during the fall following early rains. This species was recorded at about half the survey stations on winter range and at three-fourths of those on summer range.

SEASON OF GROWTH

Plant growth generally begins in late March or early April and continues as long as there is sufficient soil moisture. Late summer or early fall rains occasionally produce additional growth in some species. About 70 percent of the 13.18 inches of average annual precipitation received at Miles City falls during the April to September growing season (table 1). More than 35 percent of this precipitation occurs during May and June, the 2 months of greatest rainfall. This usually provides the moisture necessary for full development of a forage crop. Rainfall decreases during July and August and normally less than an inch occurs during September. Winter precipitation, usually in the form of snow, and early spring precipitation are light.

Sandberg bluegrass and threadleaf sedge begin to grow as soon as daytime temperatures rise well above freezing. They flower and produce seed early in the growing season and become dormant when

TABLE 1.—*Growing-season and annual precipitation recorded at Miles City, Mont., 1936–45*

Year	April	May	June	July	Aug.	Sept.	Total precipitation	
							Growing season	Annual
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1936	0.23	1.12	0.15	1.00	0.39	0.69	3.58	6.06
1937	.79	.81	2.00	1.76	1.33	.77	7.46	10.42
1938	.41	2.46	2.96	.89	.95	.34	8.01	11.23
1939	.94	1.35	4.11	1.01	.50	.62	8.53	9.87
1940	1.92	1.65	2.48	1.78	.93	.51	9.27	14.14
1941	1.65	1.94	2.70	2.02	2.43	4.01	14.75	17.76
1942	.93	2.83	4.28	1.44	1.16	.78	11.42	13.97
1943	.29	1.38	6.12	1.04	2.57	.31	11.71	15.01
1944	1.53	1.49	9.78	.68	2.09	.87	16.44	18.95
1945	.59	2.95	2.01	1.53	1.23	1.91	10.22	12.60
Average, 1878–1945	1.06	1.98	2.76	1.50	1.12	.98	9.40	13.18

hot weather begins. Bluestem wheatgrass and needle-and-thread begin growth early in the spring, too, but they require slightly warmer days before growth is significant. During late April and early May, when maximum daytime temperatures reach into the seventies, these species make rapid growth. Also, they usually remain green longer than other species, until middle or late July.

Warm temperatures usually prevail in May and June and provide ideal growing conditions for the development of blue grama and buffalograss. These are warm-weather grasses, and show no signs of spring growth until most of the other species are rather well along. By May 15, the date when grazing was shifted from winter to summer range, blue grama and buffalograss had completed only 55 and 65 percent of their height growth respectively (table 2), while the earlier species, bluestem wheatgrass, needle-and-thread, Sandberg bluegrass, and threadleaf sedge, had ordinarily completed 70 to 85 percent of their height growth. July and August are generally rather hot and dry with temperatures reaching well over 100° F. in most years. Except in years of unusual moisture conditions, there is very little plant growth during August. In the fall months, however, temperatures often prevail that are warm enough to revive growth if sufficient moisture is available.

Table 2.—*Starting date and average seasonal development of fully extended basal leaves of five important northern Great Plains range species observed from 1933 to 1944*[1]

Species	Date growth began	Average leaf height May 15	Maximum leaf height	Date maximum height attained
		Inches	*Inches*	
Threadleaf sedge	Middle to late March	4. 2	5. 0	June 10
Bluestem wheatgrass	Late March to early April.	6. 4	9. 1	July 10
Needle-and-thread	Late March	[2] 6. 1	7. 9	June 10
Blue grama	Middle to late April	2. 1	3. 9	July 15
Buffalograss	Late April	2. 7	4. 2	July 10

[1] Based on a separate but closely associated study.
[2] Estimated.

Season of Use

Usually, Sandberg bluegrass and threadleaf sedge were ready for grazing early in April, and by the middle of the month they furnished considerable quantities of highly palatable forage. Rather intensive use of these species continued as a rule until about May 15 when the cattle began to graze bluestem wheatgrass. The single-stem growth habit of this species made it less attractive for earlier use, but throughout the remainder of the year it was an important contributor to the forage supply. With the advent of warm weather, usually in late May, the shortgrasses and needle-and-thread began to furnish substantial amounts of forage. This generally lessened the heavy use of bluestem during the summer months, except where it occurred in dense stands. With freezing weather in the fall, the shortgrasses contributed less prominently to the forage supply and the use of bluestem increased. Needle-and-thread continued to furnish considerable forage into the fall and winter.

TABLE 3.—*Utilization data for important forage species on moderately stocked northern Great Plains ranges, by year, 1939–45*

SUMMER RANGE

Item	1939	1940	1941	1942	1943	1944	1945	Average
Stubble height:	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Bluestem wheatgrass	3. 5	2. 7	2. 2	5. 6	3. 7	4. 4	3. 9	3. 7
Blue grama	. 7	1. 0	. 8	1. 0	1. 2	1. 2	1. 2	1. 0
Needle-and-thread	-----	-----	-----	-----	1. 6	1. 6	1. 5	1. 6
Plants grazed:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Bluestem wheatgrass	51	68	62	51	44	41	70	55
Blue grama	40	55	39	31	41	20	64	41
Needle-and-thread	-----	59	47	22	62	29	70	48
Buffalograss	60	62	39	74	64	65	81	64
Utilization:								
Bluestem wheatgrass	25	34	42	22	24	20	40	30
Blue grama	33	25	23	16	18	11	28	22
Needle-and-thread	-----	-----	-----	-----	39	19	45	34

WINTER RANGE [1]

Item	1939	1940	1941	1942	1943	1944	1945	Average
Stubble height:	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Bluestem wheatgrass	3. 8	3. 1	1. 9	-----	-----	-----	3. 9	3. 2
Blue grama	. 7	1. 6	. 7	-----	-----	-----	. 9	1. 0
Needle-and-thread	-----	-----	-----	-----	-----	-----	. 9	-------
Threadleaf sedge	1. 2	1. 9	1. 9	-----	-----	-----	1. 5	1. 6
Plants grazed:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Bluestem wheatgrass	84	68	80	-----	-----	-----	33	66
Blue grama	57	21	42	-----	-----	-----	20	35
Needle-and-thread	-----	-----	-----	-----	-----	-----	48	-------
Threadleaf sedge	59	32	26	-----	-----	-----	31	39
Silver sagebrush	-----	-----	37	-----	-----	-----	16	26
Black greasewood	-----	-----	17	-----	-----	-----	56	36
Utilization:								
Bluestem wheatgrass	47	37	53	-----	-----	-----	18	39
Blue grama	41	13	26	-----	-----	-----	13	23
Needle-and-thread	-----	-----	-----	-----	-----	-----	39	-------
Threadleaf sedge	27	10	8	-----	-----	-----	11	15

[1] Utilization measurements based on forage produced in previous growing season.

During the winter months, especially if there was snow on the ground, bluestem was the only grass species that consistently provided forage. Browse species were especially important. Not only did they furnish nutritious forage for the livestock, but they seemed to protect the grasses under them from heavy snow and to make them more readily available for grazing.

Degree of Utilization

Percent of plants grazed was the most sensitive indicator of the degree to which a forage species had been grazed. Rather consistently throughout the 7 years of the survey on the moderately stocked summer range, buffalograss had the highest proportion of plants grazed, averaging 64 percent (table 3). Bluestem wheatgrass, needle-and-thread, and blue grama followed in descending order. However, on the winter range bluestem wheatgrass showed the highest percent of plants grazed, while slightly more than half as many threadleaf sedge and blue grama plants were grazed. On the basis of only 1 year's data, the percentage of needle-and-thread plants grazed was similar to that of bluestem wheatgrass.

Stubble heights, too, were indicators of degree of grazing, but, because of variations in growth form within species, they could be compared only indirectly. An average 2-inch stubble of bluestem would indicate 78 percent removal of the plant (fig. 2). The same stubble height of needle-and-thread shows 56 percent use; on blue grama, 29 percent, and on threadleaf sedge, 25 percent. On moderately stocked summer range, bluestem stubble averaged 3.7 inches as compared to an inch for blue grama and 1.6 inches for needle-and-thread. On winter range, stubble heights averaged about the same as on summer range but varied somewhat in individual years.

Throughout the study, utilization percentages were the products of these two factors, percent of plants grazed and percent of plant weight removed at average stubble heights. The relation of these factors to one another depended upon current growing conditions and the amount of herbage produced by a given species in any year.

UTILIZATION VARIED FROM YEAR TO YEAR

As previously pointed out, forage utilization on a range is determined by the number of animals grazed and length of grazing season. To avoid overuse these should be balanced against herbage production for the year. In the experiment, numbers of animals were held constant except for small annual variations in calf crops, and length of grazing season was rather uniform throughout the study. Utilization obtained under moderate stocking (2.5 acres per cow month) most closely approached the level believed to be proper for northern Great Plains range grazed by cattle. Consideration of grazing under moderate stocking, however, revealed variations in utilization between years that were due to factors other than livestock numbers and length of grazing season.

Throughout the study, the range was recovering from the drought of the midthirties, and herbage production was on the increase. In some years, temporary transitory species produced abundantly. The 1944 forage crop was exceedingly abundant following four successive better than average years. The 1938 growing season was below average from the standpoint of precipitation and the range had not yet recovered from the effects of the great drought. Also, the spring of 1939 was unusually dry. The utilization data reflected these fluctuations, altered somewhat by variations in precipitation patterns and length of the green-forage season.

Fluctuations on Summer Range

Year-to-year fluctuations in utilization of forage on the summer range were largely the result of variations in weather and in subsequent herbage production. No doubt these fluctuations of utilization would have been greater had one or more years of adverse weather occurred. With all species, percent of plants grazed was the most sensitive indicator of fluctuations in utilization.

On the summer range pastures, moderately stocked, bluestem wheatgrass was grazed more than twice as heavily in 1941, the heaviest year, as in 1944, the lightest year (table 3). In 4 of the 7 years, utilization of this species was 25 percent or less, and for the entire period the average was 30 percent. Shortest average stubble of bluestem occurred in 1941, the year of heaviest utilization, and the tallest occurred in 1942, a year of low utilization. The cattle tended to remove about 5 or 6 inches of the plants regardless of their initial average height, and, except on bottom subtypes, usually grazed the plants only once.

In 1939, bluestem was rather scattered, but because of the heavy June precipitation, Sandberg bluegrass and many weeds produced abundantly and furnished the bulk of the forage. Therefore, bluestem was grazed rather lightly that year. In 1940, however, bluestem produced abundantly and more of its plants were grazed, while the temporary invaders began to decline. From that time until 1945, the yearly production of bluestem increased and the number of plants grazed decreased. Even though the range had fully recovered from effects of the drought by 1945, adverse growing conditions that year caused a marked reduction in herbage production and a subsequent increase in the utilization of bluestem wheatgrass.

Utilization of blue grama fluctuated even more than that of bluestem wheatgrass. In 1944, range production had built up to a peak and the abundance of herbage made the utilization of all species rather light. Only 11 percent of available blue grama herbage was grazed. In 1939, a year of low production, with the same cattle on the same pastures, 33 percent of available herbage was utilized. Although the density of blue grama was rather low, 1939 was an ideal season for the growth of this species. The early spring was warm and, except for the residual winter moisture, was rather dry. These conditions caused grama to begin growth earlier than usual and to take advantage of steady rains that began late in May and continued through most of June. Blue grama was the most abundant and succulent species on the range so the cattle naturally ate considerable quantities of it. As with bluestem wheatgrass, the grazing of blue grama gradually but steadily declined as the range improved and recovered from the drought.

The wide range in utilization of needle-and-thread between the high of 1945 and the low of 1944 was due to a fluctuation in the percent of plants grazed. Stubble heights were nearly identical in the 3 years they were measured. The percent of plants grazed in 1942 was even lower than in 1944 and less than one-third as great as the 70 percent grazed in 1945. By 1942, needle-and-thread plants were abundant and all species made more height growth than in any other year of the study. Precipitation during May and June was considerably above normal and the green-forage season extended well into the summer. Grazed plants that grew again were often regrazed in preference to plants that carried ungrazed spring growth throughout the season.

Like all other species studied, a higher percentage of buffalograss plants was grazed in 1945 than in any other year. The lightest use of this species was made in 1941. It grew particularly well under the weather pattern that year, and growth continued all summer. Under such conditions, and with most forage species, once a plant is grazed its chances of being regrazed are increased; plants not previously grazed may remain ungrazed all season. Thus, considerable buffalograss herbage was grazed in 1941, yet a relatively small percentage of the plants carried the load. In 4 out of 7 years, 60 to 65 percent of the plants were grazed. Wide fluctuations in use occurred only during unusually good years.

Fluctuations on Winter Range

Winter use was measured in only 4 years. Measurements were made in the spring on herbage produced during the previous growing season. The lightest use was recorded in 1945 and the heaviest in 1939, when the winter grazing season was extended 2 weeks to benefit summer ranges that were dry and unusually late. Fluctuations in use that occurred between years on winter range were reflected by each of the major forage species.

Bluestem wheatgrass, like most other important forage species, made abundant growth in 1944. Thus, more than the usual amount of bluestem herbage was available during the winter of 1944–45 with the result that fewer plants were grazed than usual and stubbles were taller than during any other winter. In 1940, however, bluestem attained less height growth than in any other year of the study, and during the following winter a higher than usual percentage of the plants was grazed. Stubbles were exceeding low. For the 4 years that utilization was measured on the winter range, grazing on bluestem averaged somewhat higher than on the summer range. The fact that bluestem is not usually covered as deeply by snow as some of the other species may have been the reason for its higher average grazing percent on the winter range.

As on the summer range, winter utilization of blue grama was three times as great in some years as in others. Under moderate stocking during the winter of 1938–39, about two-fifths of the grama herbage produced in 1938 was grazed. In 1940 and 1945, only 13 percent of the grama crop was used, and during the 4 years that the species was measured, less than a quarter of the total. Blue grama is not as dependable for winter grazing as for summer grazing because of its short growth form. A few inches of snow will cover up the plants, and, in winters of considerable snow, they may not receive much grazing.

The percentage of needle-and-thread plants grazed was lower on the winter than on the summer range in 1945, the one year that this species was observed on the winter range. However, the level of utilization for needle-and-thread that year was 5 percent higher than its average utilization over a 6-year period on the summer range.

Threadleaf sedge grows on sandy ridges and south slopes and is one of the first range plants to green up in the spring. Generally, it is not grazed appreciably at any other time of the year. The degree to which it is grazed depends upon the earliness of the spring, the amount of herbage it produces, and the time that green forage of other species becomes available. Also, the degree to which this species is utilized depends upon how it was grazed the previous year because, unlike the true grasses, the same leaves continue to grow from year to year. Utilization varied from less than one-tenth to more than a quarter of the herbage produced on the winter range. For the 4 years, about one-seventh of the threadleaf herbage was grazed on winter range.

Two years of observation of silver sagebrush and black greasewood indicate that utilization of shrubby species may fluctuate considerably in relation to each other as well as between years. In the winter of 1940–41, about two-fifths of the silver sagebrush plants and less than one-fifth of the black greasewood plants were grazed. In the winter of 1944–45, the pattern of grazing of these two species was reversed. Less than a fifth of the silver sagebrush plants but more than half of the black greasewood plants received some use. Many of the shrubby species are typically high in protein and carotin and therefore substantially supplement the herbaceous range species during winter. Grazing of these species is greatest during severe winters.

Utilization on the winter range was often complicated by weather and snow conditions. Deep snow rendered the forage plants unavailable, except on windswept ridges, and this sometimes necessitated considerable supplemental feeding. The grazing of range plants under these conditions was not as heavy as during years of light snow and mild temperatures. Forage grazed during the winter was produced the previous growing season, so, undoubtedly there was always some loss of herbage due to weathering, rodents, and insects.

UTILIZATION VARIED BY RANGE SUBTYPES

Range subtypes are characterized by different combinations of soil, topography, and composition of plant species. In the northern Great Plains region three subtypes are recognized for convenience—the bottoms or flood plains along the streams, the hills far back from the streams, and the uplands or intermediate areas. These combinations have a pronounced effect upon the movements and grazing habits of cattle. In the experimental pastures the effect of the upland and bottom subtypes on the cattle was especially noticeable.

The largest subtype on northern Great Plains ranges is the rolling uplands. The soils are generally rather deep, sandy and sandy-clay loams. Blue grama, bluestem wheatgrass, and threadleaf sedge are the dominant plants. Sandberg bluegrass is an associated species throughout this subtype and needle-and-thread is prominent on the lighter, sandier soils. Big sagebrush is scattered throughout these rolling uplands. On summer range, this subtype was grazed more lightly than any other. During winter it received about the same amount of grazing as did the hills subtype.

The hills subtype occurs well back from the streams and water courses on slopes of relatively small hills in areas where the range is sharply cut and broken by centuries of rapid natural erosion. The soils of these rough areas are highly variable, and they may be heavy and rocky, or frequently alkaline. The principal grasses are bluestem wheatgrass, blue grama, and needle-and-thread. Other important species are alkali sacaton, side-oats grama, Indian ricegrass, and stonyhills muhly; bluebunch wheatgrass occasionally occurs on the north slopes. Big sagebrush grows abundantly in this subtype while other shrub species such as black greasewood, shadscale saltbush, Gardner saltbush, greenplume rabbitbrush, silver sagebrush, and falsetarragon sagebrush are found in scattered stands. On the summer experimental pastures, a variation in this subtype, which was not present on the winter range, occurred as fringes of broad flats having heavy, poorly drained, alkaline soil. These flat areas supported sparse stands of bluestem wheatgrass with some green needlegrass and buffalograss. During this study, utilization of the hills subtype on the summer range was intermediate between that observed on the upland and bottom subtypes.

The bottoms or flood plains of the streams are somewhat similar in soil and composition of plant species to the subtype just described, but they are much more productive. They are frequently flooded, and the water-deposited soils are rich and high in organic matter. Dense stands of bluestem wheatgrass are produced, sometimes in association with buffalograss, green needlegrass, and silver sagebrush. This bottom subtype is the most productive one on the Great Plains ranges. In the experiment it was more heavily grazed than either the hills or upland subtypes on both summer and winter range.

Percent of plants grazed and percent of utilization of bluestem wheatgrass in the bottom subtype on summer range were nearly twice as great as in the upland subtype and nearly half again as great as in the hills (table 4). On the winter range, utilization of this species was also considerably greater in the bottom than in the other two subtypes. Observations made during the utilization surveys showed that when growing in mixture with other species on the summer range, bluestem was not grazed as heavily by the cattle as were some of the other important species. In dense and relatively pure stands, it was grazed more heavily. There was not much difference in the heights of stubble on the subtypes on either winter or summer range.

On summer range, blue grama was also grazed twice as much in the drier fringes of the bottom subtype as in the upland subtype, and 50 percent more than in the hills. In winter, blue grama received five-eighths as much grazing in the uplands and hills as in the bottoms. Again, stubble heights in the different subtypes were about the same so that differences in utilization of blue grama were determined by the percentage of plants grazed.

Percent of buffalograss plants grazed showed the same relationship between subtypes as the other species. The upland and hills subtypes had about two-thirds as many plants grazed as the bottom subtype.

Needle-and-thread, which almost never occurs in the bottom subtype, was grazed about equally in the upland and hills subtypes.

TABLE 4.—*Utilization data for important forage species on northern Great Plains range, by range subtype, all grazing intensities combined*

SUMMER RANGE—1939–45

Item	Hills subtype	Upland subtype	Bottom subtype
Stubble height:	*Inches*	*Inches*	*Inches*
Bluestem wheatgrass	3. 2	3. 9	3. 5
Blue grama	. 8	. 9	. 9
Needle-and-thread	2. 0	1. 5	(1)
Plants grazed:	*Percent*	*Percent*	*Percent*
Bluestem wheatgrass	57	47	78
Blue grama	46	35	69
Needle-and-thread	66	50	(1)
Buffalograss	52	54	78
Utilization:			
Bluestem wheatgrass	34	24	45
Blue grama	28	20	41
Needle-and-thread	37	37	(1)

WINTER RANGE—1939–41, 1945

Item	Hills subtype	Upland subtype	Bottom subtype
Stubble height:	*Inches*	*Inches*	*Inches*
Bluestem wheatgrass	3. 1	3. 3	2. 8
Blue grama	. 9	. 9	. 7
Needle-and-thread	. 9	. 9	(1)
Plants grazed:	*Percent*	*Percent*	*Percent*
Bluestem wheatgrass	67	65	82
Blue grama	38	38	55
Needle-and-thread	59	49	(1)
Utilization:			
Bluestem wheatgrass	35	37	54
Blue grama	26	25	40
Needle-and-thread	37	40	(1)

[1] Not present on this subtype.

Bottom areas were grazed more heavily than other subtypes. On summer range, available water and abundant forage that remained green well into the summer grazing season attracted the cattle. In winter, protection from the weather was sought in the bottoms.

Ordinarily, bottom subtypes can withstand heavier grazing than the drier upland and hilly areas. However, too much trampling by cattle when the soils are wet will cause compaction with a consequent reduction in soil permeability to rainfall. Because cattle naturally tend to concentrate in these areas, one of the aims of management should be to make the upland areas more attractive and thereby improve the uniformity of grazing over the entire range. Too heavy grazing of the bottom subtype may so weaken the desirable plants as to permit the invasion of sagebrush and other species of low value.

UTILIZATION VARIED BY STOCKING RATES

Two experimental pastures on both summer and winter range were stocked moderately, two heavily, and two lightly. Since 10 head of cows were grazed in each pasture, the various stocking rates were set by allowing different acreages of range per animal. Because the range varied somewhat in productivity, these surface-acre allowances were based on forage acres originally determined from a range survey made in 1933.[5] In 1940, the first year after the utilization study was begun, the range was resurveyed and forage acres per range pasture and per animal were recompiled. The recompilation showed that the stocking was reasonably consistent between paired pastures. Therefore, actual stocking remained the same throughout the study with 10 cows and their calves in each pasture.

Considering the summer and winter ranges combined, 4 pastures were stocked 34.1 percent heavier and 4 12.4 percent lighter than the 4 on moderately stocked range on the basis of the 1940 forage-acre inventory. Winter range pasture R, planned for light stocking and with surface acres ordinarily considered ample to carry 10 cows at that level of stocking, had too few forage acres for light stocking and consequently was moderately grazed in most years. The value of using forage acres as a basis for stocking is shown in this study by the close relation between forage acres per pasture and the level of utilization obtained in each.

On summer range, moderate grazing removed about a third of the bluestem herbage. This utilization was distributed over about half the plants that were grazed on the average to a stubble height of slightly less than 4 inches (table 5). Under heavy stocking, nearly three-fourths of the plants were grazed and the average stubble height was less than 3 inches (fig. 3). Nearly half of the bluestem herbage was taken on the average over the 7-year period under heavy stocking. Under light stocking only about one-fourth of the bluestem was removed. Stubbles were a full inch taller than under heavy stocking and less than 50 percent of the plants were grazed. There was almost no difference in utilization of bluestem between the two pastures of each intensity.

On winter range, bluestem wheatgrass was utilized slightly more heavily under all rates of stocking. Because the cattle were less selective in the winter, they grazed more uniformly than on summer range. Percentages of bluestem plants grazed were greater than on summer range, especially under moderate and light stocking, but showed less difference between pastures and intensities. Between the

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[5] HURTT, LEON C. MANAGING NORTHERN GREAT PLAINS CATTLE RANGES TO MINIMIZE EFFECTS OF DROUGHT. U. S. Dept. Agr. Cir. 865, 24 pp., illus. 1951.

TABLE 5.—*Utilization data for important forage species on two sets of experimental pastures, northern Great Plains range, by different rates of stocking*[1]

SUMMER RANGE—1939–45

Item	Heavy stocking			Moderate stocking			Light stocking		
	Pasture A	Pasture E	Total or average	Pasture C	Pasture D	Total or average	Pasture B	Pasture F	Total or average
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Pasture surface	124. 9	90. 8	215. 7	130. 6	133. 1	263. 7	170. 0	195. 6	365. 6
Pasture forage[2]	15. 4	16. 0	31. 4	25. 8	24. 4	50. 2	27. 4	31. 3	58. 7
Stubble height:	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Bluestem wheatgrass	2. 7	3. 1	2. 9	3. 8	3. 7	3. 7	4. 0	3. 9	3. 9
Blue grama	. 8	1. 0	. 9	1. 0	1. 0	1. 0	1. 0	. 9	1. 0
Needle-and-thread	1. 0	1. 4	1. 3	1. 5	1. 7	1. 6	1. 8	2. 2	1. 9
Plants grazed:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bluestem wheatgrass	71	75	72	52	58	55	49	46	47
Blue grama	60	48	56	45	37	41	38	34	36
Needle-and-thread	81	65	69	52	43	48	47	40	44
Buffalograss	77	78	77	79	60	64	54	41	45
Utilization:									
Bluestem wheatgrass	47	45	47	28	32	30	24	24	24
Blue grama	36	26	32	24	19	22	20	19	19
Needle-and-thread	62	45	54	40	28	34	31	18	27

WINTER RANGE—1939–41, 1945

Item	Heavy stocking			Moderate stocking			Light stocking		
	Pasture Q	Pasture T	Total or average	Pasture S	Pasture U	Total or average	Pasture R	Pasture V	Total or average
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Pasture surface	135. 8	110. 1	245. 9	179. 6	166. 9	346. 5	201. 5	208. 1	409. 6
Pasture forage [2]	16. 8	21. 1	37. 9	25. 7	29. 2	54. 9	24. 9	34. 5	59. 4
Stubble height:	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Bluestem wheatgrass	2. 6	3. 0	2. 8	3. 1	3. 1	3. 1	3. 2	3. 6	3. 5
Blue grama	. 8	. 9	. 9	1. 0	. 9	1. 0	. 8	. 9	. 9
Threadleaf sedge	1. 5	1. 7	1. 6	1. 6	1. 6	1. 6	1. 6	1. 8	1. 8
Plants grazed:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bluestem wheatgrass	76	75	76	66	66	66	67	64	65
Blue grama	55	47	50	37	35	35	38	29	33
Threadleaf sedge	51	45	47	36	39	39	48	34	38
Needle-and-thread	70	68	69	68	62	65	51	46	48
Utilization:									
Bluestem wheatgrass	51	47	49	39	39	39	40	33	36
Blue grama	37	32	34	24	23	23	26	19	22
Threadleaf sedge	20	16	17	13	14	14	17	12	13

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[1] Actual stocking, 10 cows per pasture; different stocking rates reflected by surface-acre allowances per animal, based on forage acres.

[2] 1940 resurvey.

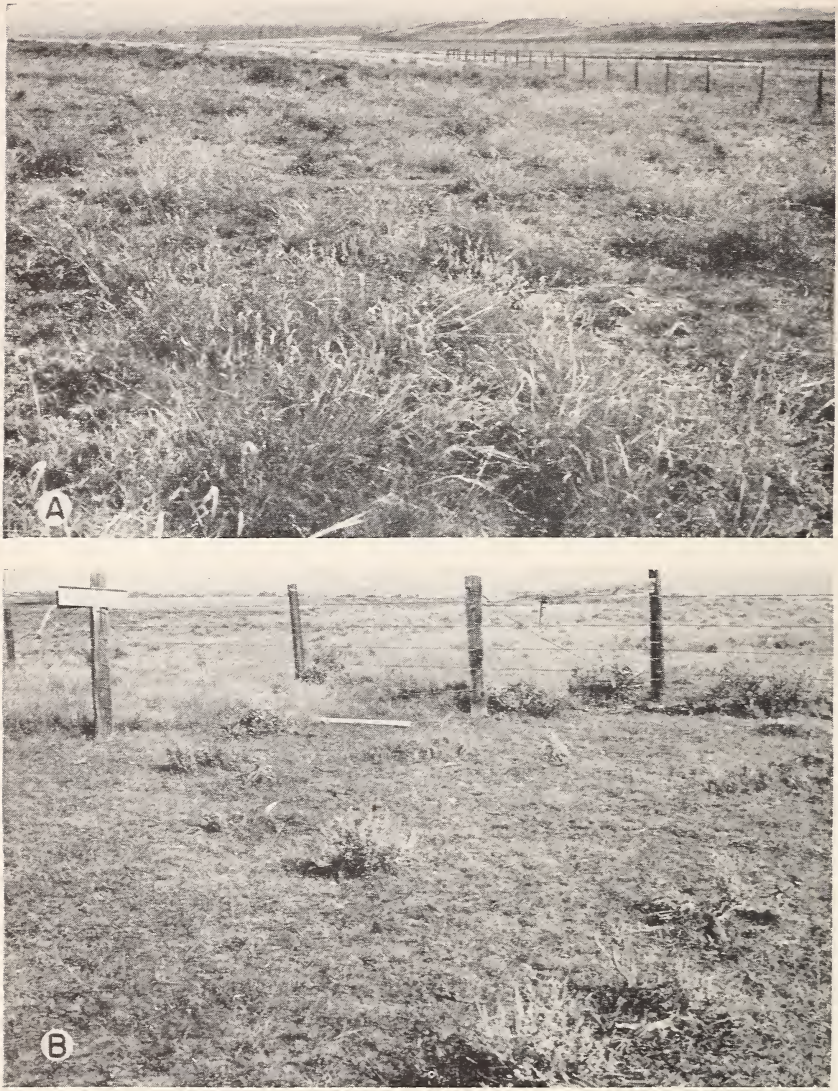

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FIGURE 3.—*A*, Taller stubbles and a higher percentage of plants left ungrazed on moderately stocked ranges provide considerable plant residue for soil improvement and moisture retention; *B*, close grazing under heavy stocking leaves little residue.

two pastures of each intensity, the grazing of bluestem was similar except on the lightly stocked range. Even there the utilization was correlated with the estimated forage acres. There were actually fewer forage acres available in pasture R than in either of the moderately stocked winter pastures S and U. This again resulted in slightly heavier utilization of blue grama and threadleaf sedge in R than in either of the two moderately grazed winter pastures.

Average utilization of blue grama on both winter and summer ranges was about two-thirds as great under moderate stocking as under heavy stocking. There was little difference in utilization between moderate and light stocking on either winter or summer range. Fluctuations in blue grama utilization were determined almost entirely by the percent of plants grazed. On both the winter and summer range, average stubble heights varied only 0.1 inch between different rates of stocking. Out of more than 8,000 stubbles of blue grama that were measured during this study, two-thirds were 1 inch or less in height and nine-tenths were less than 1½ inches. Approximately 40 percent of the herbage weight in blue grama plants lies below an inch, between 50 and 60 percent being removed at this level (fig. 2, p. 4).

Utilization of needle-and-thread averaged higher under the several rates of stocking on both summer and winter ranges than that of most other species. On heavily stocked summer range, this may have been partly because the needle-and-thread was near water. Even on lightly stocked summer range, about a fourth of the needle-and-thread herbage was taken. Needle-and-thread was even more heavily grazed on the winter range. This grazing pattern indicates a high yearlong grazing value for this species.

Threadleaf sedge, observed only on the winter range, was grazed to about the same average stubble regardless of the rate of stocking. Since this species grows only on certain sites, some pastures of equal grazing capacity had more sedge than others. In the early spring, it was avidly eaten in all pastures and, as a result, did not reflect differences in rates of stocking as well as other important species.

On summer range, the percentage of buffalograss plants grazed varied directly with rate of stocking. Moderately stocked range pasture C had 79 percent of its plants grazed, partly because the buffalograss was in a bottom area where there was temporary stock water and where the cattle tended to concentrate. In contrast, all of the buffalograss in lightly stocked range pasture F was on the upland and a considerable distance from stock water; 41 percent of its plants were grazed. The relatively high percent of plants grazed under all intensities showed buffalograss to be a valuable forage species.

UTILIZATION VARIED WITH DISTANCE FROM STOCK WATER

Watering habits on the experimental range were rather regular. On hot days the cattle usually walked directly to the well about 9 a. m. and stayed around until 4 or 5 p. m. They often drank several times a day, then grazed away from the watering place in late afternoon. On cooler days they spent less time around the watering place. Campbell[6] has reported that on southwestern cattle ranges utilization of black grama varied directly with distance from stock water. The survey pattern used in this study permitted the segregation of data according to distance from the central watering place.

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[6] CAMPBELL, R. S. PROGRESS IN UTILIZATION STANDARDS FOR WESTERN RANGES. Wash. Acad. Sci. Jour. 33: 161–169, illus. 1943.

On the summer range, a very close relation between distance from water and degree of herbage utilization was disclosed (fig. 4). For example, around the central well utilization of bluestem wheatgrass was nearly 100 percent, but within the first 200 yards it dropped to about 30 percent and remained relatively unchanged to the farthest part of the range pastures. Likewise, utilization of blue grama was heavy near the well but declined to 20 percent within the first 200 yards. However, grazing increased again at about 800 yards and was just about as heavy from there to the farthest part of the pastures as at 200 yards from the well. This may have been due in part to the

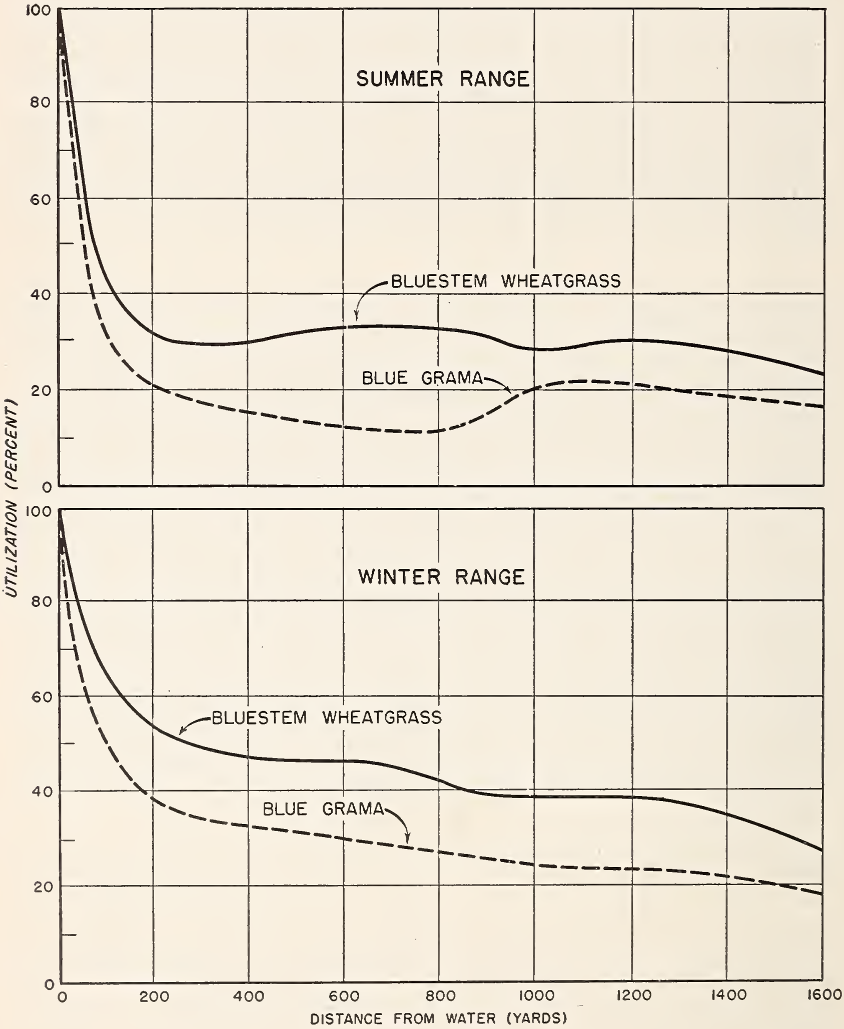

FIGURE 4.—Grazing was heavy near the central well on both summer and winter range and decreased gradually as distance from water increased.

availability of temporary water in the far side of several of the pastures. Blue grama was grazed more heavily near this water than on areas near the center of the pastures.

On the winter range, the average utilization of bluestem within 200 yards of the central well was about 54 percent and for blue grama about 38 percent. There was a gradual decrease in grazing of both species as distance from the central watering place increased. The topography of the winter range was much rougher than that of the summer range, and this combined with snow conditions and adverse weather prevented uniform forage utilization. In the winter, hay was fed in special pens at the central well where warm drinking water was available. Sheds for protection from the weather were located midway between the watering place and the most remote part of each range pasture. These arrangements caused the cattle to move around and tended to reduce concentration at the well.

Although the pattern of grazing shown in figure 4 may not prevail on other ranges of the northern Great Plains, there can be no doubt that in this study there was a real relation between the location of water and the intensity of utilization. The most important fact, however, is that heavy utilization occurred within 200 yards of water on both winter and summer range. Even in the lightly stocked pastures there was a concentration of grazing close to permanent water. This concentration was more pronounced on summer ranges because the hot, dry weather caused the cattle to spend more time near the water. More and smaller watering facilities placed closer together would have reduced this concentration at any one place.

UTILIZATION AND MANAGEMENT ON A RANGE BASIS

Proper Stocking is the Key

The aim of management is to make the best possible use of a range and still maintain its production at a high level. This aim can be attained only if proper stocking and sound range management planning are applied. Proper stocking means more than simply placing a certain number of livestock on the range for a given period of time, because uniform utilization of forage to the proper degree over *all* parts of the range is the objective. As discussed earlier there is considerable variation in utilization of important forage species from one year to another, between subtypes, and with distance from stock water. It should be the goal of management to eliminate as much of this variation as possible.

On the northern Great Plains it is wise to divide the range into at least two units, one for summer grazing, the other for winter grazing. The winter range should afford as much natural protection from weather for the cattle as possible, but should be accessible so that the cattle can be reached or moved in emergencies. Because forage plants are generally low in nutritive value during the winter and livestock require more forage for maintenance, more range should be allowed than is provided for summer grazing.

The study reported here was made during a period of relatively favorable weather and high herbage production. Yet under moderate stocking as high as 80 percent of the plants of certain species were grazed in some years. This was higher than the average percent of plants grazed under heavy stocking and serves to illustrate that a margin of safety in range allowances per animal is wise. Table 6 is presented as a guide to the percent of plants of the major forage species that can be safely grazed on winter and summer range under proper stocking. These data were derived from the experimental ranges and adjacent areas and, although they serve only as a tentative guide, they are the best available guide to proper utilization.

Yearly variations in herbage utilization due to weather, grasshopper infestations, and other factors are certain to occur even on properly stocked ranges. Minor adjustments in stocking may therefore be necessary to allow the range to recover after a dry or otherwise unfavorable year in which more than the recommended percentage of plants are grazed. Very seldom, however, do favorable conditions in any one year warrant an increase in stocking the next. The objective of proper stocking and good management is more apt to be realized when the guides given in table 6 are followed as closely as possible.

TABLE 6.—*Guide to proper utilization of major forage species on northern Great Plains ranges: Percent of plants to be grazed*

Species	Summer range			Winter range		
	Upland subtype	Hills subtype	Bottom subtype	Upland subtype	Hills subtype	Bottom subtype
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bluestem wheatgrass	55	55	75	65	65	75
Blue grama	40	45	65	40	40	55
Needle-and-thread	55	60	-------	55	60	-------
Buffalograss	55	50	75	55	50	75
Threadleaf sedge	50	50	-------	50	50	-------

Hurtt[7] has recommended a range allowance of at least 31 acres per cow per year on northern Great Plains ranges. He also recommends that good supplies of supplemental feeds be kept on hand for use when there is a drought or a severe winter. A pinch in either feed or range forage is quickly reflected in lower livestock production and sometimes in actual losses.

Weather records show that drought, with consequent low forage production, occurs in the northern Great Plains on an average of 1 year out of 5. In such cases the grazing season must be shortened and large amounts of supplements fed or livestock numbers drastically reduced. Although reductions are always difficult, they are easier if the herd is partially made up of steers. These animals can be disposed of without reducing the productivity of the operation. However, close culling of cows at such times is also a wise practice.

Obtaining better distribution of livestock grazing over the entire range offers great opportunity for more efficient forage and livestock production, and yet is one of the most difficult aspects of management.

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[7] See footnote 5, p. 15.

Cattle graze the most attractive areas first perhaps because of kind or abundance of forage, the availability of water or salt, or the presence of shade and protection from weather. Because bottom areas are utilized more heavily than other subtypes, management practices should be directed toward making the uplands more attractive to the cattle.

Development of watering places is one of the best ways of getting better distribution of grazing over the range. Insofar as possible, these should be on upland range and spaced so that cattle do not have to travel more than one-half mile in any direction to water. Even small developments that take care of only a few head of cattle and that may last for only a short time are well worth while.

Salting is another means of attracting cattle to less-favored areas, and it is wise to place the salt away from the water so that it will aid in obtaining better distribution. It is not necessary to locate salt and water close together, as commonly believed. Studies in California [8] showed an average lapse of nearly 7½ hours between the time cattle ate salt and drank water; the distance between salt and water was approximately three-quarters of a mile and could have easily been traveled in 20 minutes.

If sheds or other shelters are provided as protection from the weather, they should be placed in areas where grazing is ordinarily light. An additional help in obtaining better grazing distribution is to herd cattle into areas that are not naturally attractive to them.

Use Each Species When It Is Most Important as Forage

This study, supplemented by other observations, has shown that cattle have seasonal forage preferences. Also, as pointed out, each species is best adapted to certain soils and each grows best under certain weather conditions. Therefore, a well-rounded forage utilization plan should, where possible, divide the range into parts that permit the use of certain species when they are best able to withstand use and contribute most in grazing value.

Bluestem wheatgrass is a valuable species at any time of year. However, because of its erect, upright growth form it is one of the few species that can protrude through several inches of snow and so be readily grazed during the winter months. Therefore, ranges that are predominately bluestem might well be reserved for late fall and winter grazing.

The short grasses, blue grama and buffalograss, usually are green, succulent, and highly nutritious during the summer months and should be grazed at that time. They are too short and too easily covered by snow to be of high value during the winter months.

Needle-and-thread is most useful as forage during the summer months. However, if this species is grazed by sheep when the seed are ripe but not disseminated, the sharp pointed and awned seed sometimes cause sore mouths or eyes and skin lesions with consequent losses in condition and weight of the affected animal. Grazing should perhaps be avoided at this time. Needle-and-thread is also very valuable as winter forage and there may be cases when it should be reserved for winter grazing.

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[8] BENTLEY, J. R. AUTOMATIC RECORDING OF SALTING AND WATERING HABITS OF CATTLE. Jour. Forestry 39: 832–836, illus. 1941.

Ranges that contain shrubs in any abundance should be reserved for winter grazing, because they provide valuable forage when the weather is cold and much of the grass herbage is covered with snow. Cattle seldom utilize these woody species during the summer or early fall months. Also, during severe droughts or other emergency periods, browse species may be very important.

As the winter breaks and grass begins to green up, threadleaf sedge and Sandberg bluegrass make up the bulk of the forage. Since these species grow rapidly and mature early in the season, ranges that have an abundance of them should be grazed during the early spring if they are to be managed efficiently.

A PRACTICAL METHOD OF DETERMINING FORAGE UTILIZATION

Systematic estimates of forage utilization are useful tools in range management. They give the rangeland manager a close approximation of the balance between livestock numbers and the grazing capacity of his range. They give him a picture of distribution of grazing over the range, a clue to how efficiently he is using his forage resource. Some range operators, through years of experience, can judge proper utilization of their ranges without systematic observations. Others need a simple quantitative measure to use as a guide. An adaptation of the method used in this study, involving only a tally of grazed and ungrazed plants is proposed to fill this need. Stoddart [9] recommended a similar count of grazed and ungrazed bluestem as a practicable method of determining grazing capacity.

Throughout the study of utilization on the experimental pastures, percent of plants grazed was the most sensitive and most useful single criterion for judging the utilization on a given area. In addition, percent of plants grazed was closely related to the grazing capacity of each range pasture, as indicated by the forage acres included in each. Grazing survey estimates made in 1940 gave 34.1 percent fewer forage acres in the heavily stocked pastures and 12.4 percent more in the lightly stocked than in those moderately stocked. The percent of bluestem plants grazed on the summer range, 1939–45, was 31 percent greater under heavy stocking and 15 percent less under light stocking than under moderate stocking. Similarly, the percent of blue grama plants grazed was 37 percent greater under heavy stocking and 12 percent less under light stocking than under moderate stocking.

This strong relation of percent of plants grazed to the forage acres in each group of pastures averaged over a period of 7 years, lends strong support to the use of percent of plants grazed for determining the relative utilization of a range. Each year the relation shifted somewhat because of differences in growth, abundance, palatability, and distribution of the associated species. This indicates that an average over a period of years is probably the only safe basis for making adjustments in range stocking.

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[9] STODDART, L. A. RANGE CAPACITY DETERMINATION. Ecology 16: 531–533, illus. 1935.

Utilization determinations can best be made at the end of the grazing season. It is best to make them systematically by running a series of lines through a pasture, with periodic observations along the lines. The following points may serve as a guide:

1. Run lines at about ¼-mile intervals across the range.
2. Stop every 50 or 100 feet along the line and observe the bluestem wheatgrass and blue grama plants nearest to a previously designated mark, such as a prominent mark on the toe of one shoe.
3. Determine whether or not the nearest plant of each species is grazed and tally your findings. Any clump area of blue grama, needle-and-thread, and threadleaf sedge should be half or more grazed before it is tallied as a grazed plant.
4. Compute the percent of plants of each species grazed by dividing the number of plants grazed by the total number of plants observed.
5. Compare the computed percentage of plants grazed of each species with the standards for proper utilization recommended on page 22.

Whether or not adjustments in stocking are advisable following such a survey will depend on prevailing conditions the year the survey is made. For example, if the survey year is unusually favorable from the standpoint of weather and forage production and estimates of utilization are low, it would be inadvisable to increase stocking the next year. In a drought year, utilization estimates will be higher than usual and some reduction in stocking would probably be warranted. In any case the survey will at least show clearly which areas are receiving the heaviest grazing, and plans can be made to obtain better distribution over the entire range the following year.

SUMMARY

The northern Great Plains, a semiarid region, is especially well-suited for the production of range livestock. In 1951, there were 3 million cattle and calves in this area. Precipitation fluctuates widely from year to year and long-time averages over the region vary from 10 to 16 inches. Three subtypes make up much of the range: the broad bottoms of heavy, poorly drained soils dominated by bluestem wheatgrass and buffalograss; the uplands having sandy loam or sandy clay loam soils producing blue grama, needle-and-thread, bluestem wheatgrass, and threadleaf sedge; and the hills which produce a wide variety of forage plants on soils which may be heavy clay, rocky, and frequently alkaline.

The basis of a sound, highly productive range livestock operation is a proper balance between supplies of forage and feed and livestock numbers. To develop standards of forage utilization, a study was conducted on experimental pastures at the U. S. Range Livestock Experiment Station near Miles City, Mont., from 1939 through 1945. Two sets of six range pastures, one for summer grazing and one for winter grazing were used. Of these, four were lightly stocked, four moderately, and four heavily. Each set had a central well, from which the wedge-shaped pastures radiated. Utilization of important forage species was observed at regular intervals along lines run across these pastures at different distances from the watering tanks.

Observations over the 7-year period revealed considerable variation in utilization of the important forage species from year to year, between vegetation subtypes, between rates of stocking, and at different distances from stock water on both summer and winter range.

Greatest differences in utilization between years were found on winter range in blue grama and threadleaf sedge, each being grazed more than three times as heavily in one year as in another. Utilization of bluestem wheatgrass ranged from 18 to 53 percent on winter range but was less variable on summer range. Utilization of other species showed similar fluctuations even though precipitation and forage production were generally favorable during the study.

Bottom subtypes were more heavily grazed by cattle than either the upland or the hills. On summer range, the upland subtype was most lightly grazed, but on winter range there was little difference between the upland and the hills. Stubble heights for each species were much the same in all subtypes, but greater percentages of plants were grazed on bottom areas. Bluestem wheatgrass, the most abundant species in all three subtypes had 78 percent of the plants grazed on the bottom subtype as compared to 47 percent on the upland and 57 percent on the hills.

Rates of stocking were clearly reflected by differences in utilization of the major species. On heavily stocked summer range these species were utilized 45 to 60 percent more than on moderately stocked range, while on lightly stocked range they were utilized 15 to 25 percent less than under moderate stocking. There was a clear-cut difference in stubble heights between summer and winter range for bluestem wheatgrass and needle-and-thread but not for blue grama and threadleaf sedge. Percent of plants grazed reflected the differences in utilization for all species.

Utilization was rather heavy within 200 yards of the central watering tank. Beyond 200 yards, the summer range was rather uniformly grazed, but on the winter range there was a gradual decline in utilization of bluestem wheatgrass and blue grama to the far extremes of the pastures.

Uniform utilization at a proper level over the entire range is extremely important. All the tools of range management, such as stock-water distribution, salting, and herding, should be employed to obtain this goal. It is also recommended that forage species be grazed, insofar as possible, when they are most useful and most attractive to cattle: early maturing species early; summer growing species during the summer months; tall species, which cure well, during the winter.

About 31 acres per cow per year is recommended as a base for proper stocking on northern shortgrass or mixed-prairie range. This should be checked by utilization surveys, and any adjustments that appear desirable should be made. A simple method of making utilization surveys is described in this report, and a guide for judging proper utilization, based entirely on related percentages of plants grazed, is presented.